The development of a Questionnaire to Measure Hearing-Related Health State Preferences Framed in Overall Health

International Journal of Technology Assessment in Health Care, **18:3** (2002), 528–539.

DEVELOPMENT OF A QUESTIONNAIRE TO MEASURE HEARING-RELATED HEALTH STATE PREFERENCES FRAMED IN AN OVERALL HEALTH PERSPECTIVE

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Abstract

Objectives: The objective was to develop the Audiological Disabilities Preference Index (ADPI), a measure to determine health state preferences associated with audiological disabilities. The ADPI consists

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This project was funded by grants from the European Hearing Instruments Manufacturers Association and the Maastricht ENT Research Foundation, the Netherlands.

of a hearing-related health state description, hearing-related health state valuation, and transformation of the latter to the overall health scale. Research questions were: a) to determine the feasibility of ADPI in an older hearing-impaired population; b) to assess gain in health state preference after hearing aid fitting; c) to evaluate the reliability of ADPI using hypothetical health states; and d) to compare the results of ADPI with the EuroQol.
Methods: The ADPI, the marker states, and the EuroQol were administered to 78 first-time hearing aid users before and 12 and 25 weeks after hearing aid fitting.
Results: The ADPI was feasible in an older hearing-impaired population (mean age, 69.1 years). After hearing aid fitting, all dimensions of audiological disability improved ($p < .001$). Change in hearing-specific health state and the latter framed in overall health were 0.27 and 0.12, respectively ($p < .001$). The mean values of the marker states were stable, but the intraclass correlation coefficients were low. Correlations between ADPI and hearing loss and the EuroQol, respectively, were low, while moderate with hearing aid satisfaction. There was a slight change on the EuroQol visual analog scale, with only an improvement in the feeling dimension ($p < .05$).
Conclusions: The ADPI provides a practical and useful method to assess hearing-related health state preferences needed for clinical decision making and cost-effectiveness analysis.

Keywords: Hearing impairment, Utility measurement, Quality of life, Multi-morbidity, Economic evaluation

This paper presents the development and use of a preference-based instrument to evaluate generic health state: the Audiological Disabilities Preference Index (ADPI). Hearing impairment is a very common disorder, especially in older persons. In the Netherlands it affects up to 25% of the people over 55 years of age and more than 60% of the people older than 80 years (5). In an aging population, the number of hearing-impaired persons is likely to grow in the future decades. Several studies pointed out that hearing impairment is associated with social isolation, cognitive dysfunction, reduced self-reliance, loss of independence, and depression (1;14;18). In most cases, a hearing aid is the only option for rehabilitation. In light of the growing number of hearing-impaired persons and the increasing technological possibilities and price of hearing aids, there is need for an economic evaluation of hearing aids. The effects of hearing aid fitting on health state should be determined with a measure that is both preference-based and generic. A preference-based questionnaire provides the combination of scores on the items that leads to the highest overall health outcome. This is important in decisions regarding resource allocation. Moreover, in order to determine the cost-effectiveness of hearing aids relative to other healthcare interventions, the effect of hearing aids should be assessed with a questionnaire that is generic but sensitive enough to detect relevant changes in health state after hearing aid fitting. Existing measures do not meet these requirements. The development of the ADPI addresses this gap.

The only generic questionnaires used to evaluate hearing aids are the Sickness Impact Profile (SIP) and the Medical Outcomes Study Short Form 36 (MOS SF-36) (9). The SIP showed some improvement and the MOS SF-36 showed no change after hearing aid fitting (9). The MOS SF-36 is still in an experimental phase (4), and therefore not a first choice for a generic preference-based measure. The widely accepted preference-based generic health state questionnaires, such as the EuroQol 5 Dimensions (EQ-5D) (11), the Health Utility Index (HUI) (26), and the Quality of Well-being Scale (15), also seem less well suited to detect change in health state after hearing aid fitting for the following reasons. First, these questionnaires are rather general and consequently less sensitive toward relatively small and specific changes in overall health state. Second, these questionnaires focus heavily on the physical dimension of health status, which is not likely to be influenced by hearing aid fitting. The HUI does contain a sensory dimension, but the scores on the hearing, speech, and sight dimensions are clustered into the overall sensory dimension in such a way that being both blind and deaf results in the same preference score as being blind only. As recently stated by Cox, et al. (7), this result does not seem valid. Third, the presence of multi-morbidity could lead to a rescaling of the impact of hearing impairment on the overall health state. The disutility of multiple disorders is not simply the sum of the disutilities of each disorder taken separately (25). The impact of multi-morbidity on overall health state could also fluctuate over time, for instance, due to seasonal influences, and therefore bias the results of longitudinal studies.

To overcome the problems associated with the use of generic measures to assess hearing aid effect, there are a number of specific descriptive questionnaires available, such as the Hearing Handicap Inventory for the Elderly (27), the Profile of Hearing Aid Benefit (8), the abbreviated version of the latter (6), the Hearing Aid Performance Inventory (22), the Amsterdam Inventory for Auditory Disability and Handicap (16), and the Client-oriented Scale of Improvement (10). These questionnaires are without doubt sensitive to changes after hearing aid fitting but not suited to assess gain in health state for use in economic evaluations because the outcomes are not preference-based, do not provide a single index, and are not generic. The ADPI was developed to provide preferences of health states associated with hearing impairment that could be framed in overall health in order to make comparisons with other conditions. The results of the ADPI would be useful to quantify and interpret preferences for outcomes after the rehabilitation of hearing impairment and to conduct cost-effectiveness analysis of the rehabilitative options for hearing impairment.

The overall hypothesis tested in this study was whether the ADPI was a suitable measure to evaluate the effect of hearing aid fitting on hearing-specific and generic health states. This hypothesis was investigated in an intervention study of hearing aid fitting in hearing-impaired adults. The objectives were: a) to gain experience with the use of a preference-based questionnaire in an older hearing-impaired population; b) to assess gain in health state preference after hearing aid fitting; c) to evaluate the reliability of the ADPI using hypothetical marker states; and d) to compare the results of the ADPI with the EQ-5D.

METHODS

The method section consists of a description of the ADPI and a description of the studies (an intervention study and a cross-sectional study) used to evaluate the ADPI.

Development of the ADPI

The ADPI consists of a description of the hearing-specific health state, the valuation of the hearing-specific health state on a visual analog scale, and the transformation from the hearing-specific scale to an overall health state scale.

Health-specific Health State Description. In the ADPI, the health state under investigation was subjective hearing disability. The Amsterdam Inventory, a questionnaire on subjective hearing disability developed by Kramer et al. (16), was used to obtain descriptions of the domains of subjective hearing disability. This questionnaire was chosen from the available specific questionnaires for the following reasons. To our knowledge, the Amsterdam Inventory was the only questionnaire on subjective hearing disability in which different dimensions of hearing disability and handicap had been identified by factor analysis. Furthermore, a European questionnaire seemed the most appropriate for this study, since communication and public activities are likely to differ across cultures. Another reason to use this questionnaire was the availability of a validated Dutch version. The five factors from the Amsterdam Inventory ("auditory localization," "detection of sounds," "distinction of sounds," "intelligibility in noise," and "intelligibility in quiet") had substantial correlations with performance measures of auditory disability, such as hearing threshold level, speech reception in quiet, and speech reception in noise (16). The factor distinction of sounds consisted of eight questions; the remaining factors consisted of five questions. For each subjective hearing disability factor, the question with the highest loading was used in the hearing health state description. Since the Amsterdam Inventory has proved to be a valid measure of subjective auditory disability, it was assumed that the items used in the health state description were valid markers of the concept of subjective auditory disability and handicap. Every question had three possible answers: no problems, moderate problems, and severe problems. The main reason for a three-point scale was to limit the number of possible hearing-specific health states to a maximum of 243 health states (three options, five factors: $3^5 = 243$).

Hearing-specific Health State Valuation. As the ADPI was designed for use in an older hearing-impaired population, the visual analog scale, being the least difficult method of preference determination, seemed most suitable for health state preference measurement. Because the described health state concerned hearing, the endpoints of the specific visual analog scale were formulated as "deaf" and "perfect sense of hearing" instead of worst and best imaginable health state. The respondents valued their own level of subjective hearing disability on this visual analog scale, which resulted in hearing-specific health state preferences. Two hypotheses regarding the construct validity of the specific health state valuation were formulated. A low correlation between the hearing-related health state preference and hearing loss was predicted. Hearing loss was defined as the best ear pure tone average hearing loss (BEPTA) at 1, 2, and 4 kiloHertz (kHz) and was assessed by pure tone audiometry. The weak relationship between audiologically detected hearing loss (impairment) and hearing disability has been reported (3;18). The correlations between reported degree of satisfaction with the hearing aid and the change in hearing-related health state preference at the two follow-up measurements was predicted to be moderate.

Framing the Hearing-specific Health State Preferences in Overall Health. Since the endpoints of the hearing-specific visual analog scale ("deaf" and "perfect sense of hearing") are also points on the overall health state scale (ranging from "worst imaginable health state" to "best imaginable health state"), there is a relationship between both scales. The valuations of the endpoints of the specific visual analog scale were used as reference points in the positive linear transformation of the hearing-specific health state preference to the overall health state scale; hereby, the hearing-specific health state preferences were framed in the concept of overall health, which has been recommended by Gold et al. (13). The transformation of the hearing-related health state preference to the overall health state scale was performed in two ways. In the first transformation the assumption was made that the health state "perfect sense of hearing" on the hearing-specific scale was equal to the "best imaginable health state" on the overall health state scale (e.g., equal to 1). As a consequence, all health problems except those associated with hearing (multi-morbidity) were discounted for. To derive overall health state preferences without the presence of multi-morbidity, the formula below was used ($P =$ preference):

$$P_{Transformed\ Hearing\ Health\ State} = P_{Hearing\ Related\ Health\ State}[1 - P_{Deaf}] + P_{Deaf} \quad \textbf{(1)}$$

Since hearing impairment is a condition most common in older persons, who are likely to suffer from multi-morbidity, the situation in the first transformation seemed inadequate. It seemed more realistic to assign a value to the "perfect sense of hearing" health state equal to the maximum health state that a hearing impaired population would be able to reach when the hearing impairment would be fully corrected. In the second transformation, the health state "perfect sense of hearing" on the specific scale was assumed to be equal to the overall health state preference of an age-matched population without hearing-related health problems. Formula 2 for the transformation from the hearing-specific scale to the overall health state scale, when taking the presence of multi-morbidity into account, was as follows (P = preference):

$$P_{Transformed\ Hearing\ Health\ State} = P_{Hearing\ Related\ Health\ State} [P_{No\ Hearing\ Related\ Health\ Problem} - P_{Deaf}] + P_{Deaf} \quad \textbf{(2)}$$

Hypothetical Marker States. The valuation of "deaf" on the overall health state scale was determined by asking the participants in the before–after hearing aid fitting study to value "deaf" on a visual analog scale ranging from zero as "worst imaginable health state" to 1 as "best imaginable health state." To determine the test–retest reliability of the valuation of the hypothetical health state "deaf," the participants of the present study were asked to value "deaf" on the visual analog scale at all three measurement occasions. For each person the mean valuation of "deaf" over all three measurements was used in the transformation. Because of the possibility that the hearing aid intervention would cause a shift in the perception of "deaf" among participants, some additional hypothetical marker states were added to the questionnaire. The participants were asked to value the following hypothetical marker states: "mild asthma" (the use of medication is necessary, but an attack of tightness of the chest seldom occurs), "severe heart failure" (slight physical activity leads to severe complaints, such as tightness in the chest, chest pain, and fear of dying) and "blind" (not able to see anything). The marker states served as anchor points for mild ("mild asthma") and more severe ("severe heart failure" and "blind") health states. It was assumed that when the respondents attached values to the hypothetical marker states, which would not differ too much from valuations found in the literature, the respondents would also be able to attach a value to their own hearing-related health state. The value of "mild asthma" was expected to lie between 0.80 and 0.90 (17), that of "severe heart failure" between 0.30 and 0.40, and "blind" between 0.40 and 0.50 (12). Overall it was hypothesized that respondents would attach the lowest valuations to the marker state "severe heart failure," more or less the same valuations to the marker states "deaf" and "blind," and the highest valuations to the marker state "mild asthma."

The valuation of the health state "perfect sense of hearing" was assumed to be equal to the overall health state preference of a population without hearing-related problems. This value was determined in a cross-sectional study.

Intervention Study

Study Design. The study was an uncontrolled prospective intervention study with a baseline measurement and two follow-up measurements. The baseline measurement took place directly after receiving the hearing aid prescription and obtaining written informed consent. The intervention consisted of the process of hearing aid fitting, following normal procedure in the Netherlands. The first follow-up measurement (T1) took place when a satisfactory hearing aid was fitted by the hearing aid dispenser, and the second follow-up measurement (T2) was scheduled 4 months after baseline. Trained audiology assistants conducted audiometry and administered the ADPI, the EQ-5D, questions on hearing aid satisfaction, and a series of demographic questions in face-to-face interviews, taking place at the Ear, Nose, and Throat Clinic or Audiological Centre.

Study Sample. Patients were eligible for the study if they: a) were 18 years or older; b) lived in the Netherlands; c) received a prescription for a hearing aid at the Ear, Nose, and Throat (ENT) Clinic of the Maastricht University Hospital or the Hoensbroeck Audiological Centre; and d) had not used a hearing aid for the past 5 years. In the Netherlands, persons entitled to a hearing aid prescription must meet the following requirements: pure tone audiometry with an average hearing loss of at least 35 decibels (dB) at 1, 2, and 4 kHz in the best ear; hearing loss is due to inner ear pathology without indications of retrocochlear malignancies; and there are no contraindications for hearing aid use (such as draining ears or ear canal pathology). Persons not mentally capable of answering the questionnaires, unable to come to the hospital, or unable to speak and understand Dutch were not included in the study either.

EQ-5D. The EQ-5D is a short, comprehensive measure to evaluate the effect of health-care interventions on the health state. It consists of two parts: the first part consists of five questions describing the health state; and the second part is presented as the EQ-5D feeling thermometer, a visual analog scale. The following *a priori* hypotheses about the size of the gain in health state preference after hearing aid fitting measured with the EQ-5D visual analog scale and the correlation with the change in health state as measured with the ADPI were formulated. The gain in health state as measured by the EQ-5D was expected to be small. Correlation between hearing-related health state preference and the EQ-5D visual analog score was predicted to be low.

Cross-sectional Study Methods

The valuation of the "perfect sense of hearing" health state was based on the results of a cross-sectional study in a general practice carried out by the Societal Impacts of Hearing Impairment (SIHI) Study Group (23). The non–hearing disabled part of the study population was identified by asking the question, "How is your sense of hearing?" (answering options: poor, moderate, good). Persons who answered "good" were considered to be not hearing disabled. Hereafter, pure tone audiometry was performed, information on demographic variables was collected, and the EQ-5D was administered. The mean score on the EQ-5D of the non–hearing disabled subgroup was considered as an estimation of the "perfect sense of hearing" health state. A total of 245 persons of 55 years and older were included.

Statistical Analysis. The scores on the EQ-5D were recoded so that a higher score means better functioning. Comparison of means was conducted with the paired samples t test or the Wilcoxon signed ranks test. The stability of the marker states was assessed using Pearson correlations and intraclass correlation coefficients. The strength of the relationship between the hearing-related health state preference and the EQ-5D as well as hearing loss and hearing aid satisfaction was assessed by Pearson correlations. A p value smaller than .05 was considered to be statistically significant. All analyses were performed using the Statistical Package for the Social Sciences (SPSS).

Description of the Study Populations

Intervention Study. From February 1998 to March 1999, 126 patients were enrolled in the study; of these, 28% attended the University Hospital and 72% attended the Audiological Centre. T1 took place on average at 12 weeks after baseline (median 11 weeks). Although some range in the duration of the first follow-up period was inherent to the design, the average duration of the follow-up period was longer than the anticipated 6 weeks. Therefore T2, scheduled at 4 months after baseline, was rescheduled for some patients to be at least 6 weeks after T1. T2 took place on average at 25 weeks after baseline (median, 24 weeks; range, 30 weeks). To test whether the range in duration of follow-up influenced the results, Pearson correlations between the duration of the follow-up (in number of weeks) and the change in hearing-specific health state (VAS score) of the corresponding period were calculated. The correlation between the duration of the first follow up period and the change in hearing-specific VAS score in that period was low, $-.226$ ($p = .027$). The correlations between the duration of follow-up and the change in specific VAS score from T1 to T2 (correlation coefficient 0.048, $p = .690$), and from baseline to T2 (correlation coefficient, -0.056; $p = .634$) were close to zero. Altogether, duration of follow-up did not seem to affect the results on the specific VAS. After baseline, 27 patients left the study. The largest part left the study because they decided not to be fitted with a hearing aid (14 persons), one person died, one person left the study due to a severe illness, six left the study at their own request, and five were lost to follow-up. After T1, another 21 persons left the study. Of these, three decided not to keep their hearing aid, one person died, one person missed the appointment for T2 due to illness, nine left the study at their own request, and seven were lost to follow-up. Overall the persons who left the study were somewhat younger and had somewhat better hearing. A total of 78 persons completed the third and final measurement. There was a large range in age among the participants: the youngest was 29 years and the oldest was 96 years old, and the mean age was 69.14 years. The mean hearing loss was 47.37 dB at 1, 2, and 4 kHz in the best ear. There were slightly more male participants. Multi-morbidity was rather common; only seven persons reported no multi-morbidity, 41 persons presented 1–3 morbidities, and 30 persons more than three morbidities besides hearing impairment. Most of the persons were fitted with behind-the-ear hearing aids ($n = 62$), in-the-ear hearing aids were fitted in 14 cases, and only two persons were fitted with an in-the-canal hearing aid.

Cross-sectional Study. Of the 245 persons who were interviewed at the general practice to determine the value of the overall health state of the age-matched group without hearing-related problems, 90 persons valued their hearing as "good." The mean age of this group was 71.67 years (SD, 8.65; median, 72), which was comparable to the mean age in the intervention study. Mean averaged hearing loss of the best ear at 1,2, and 4 kHz was 27 dB (SD, 11.85; median, 25 dB; range, 62 dB).

RESULTS

Gain in Hearing-specific Health State

After hearing aid fitting, the mean scores on the first five questions, addressing aspects of hearing-related health states, showed a statistically significant reduction. The largest improvements were found in "detection of sounds" and "intelligibility in quiet," and the smallest improvement was in "intelligibility in noise." Prior to hearing aid fitting, the average value for the hearing-specific health state was 0.51 points. At T1 and T2, the scores were almost equal, respectively 0.77 and 0.78 points, respectively. The improvement compared to baseline was approximately 27% and was statistically significant (p value $<.0005$).

Change in hearing related health state from baseline to T2 and hearing loss (BEPTA) were not correlated ($r = -.066$). The correlation between gain in hearing-related health state and reported degree of satisfaction with the hearing aid at the second follow-up measurement was higher ($r = .389$, $p < .01$).

Framing the Hearing-specific Health State Preferences in Overall Health

The average value of the health state "deaf" over all three measurements was 0.30 for the formulas in which the average value of "deaf" per person was used. In the cross-sectional study, the mean score on the EQ-5D visual analog scale of the group without hearing-related problems (the valuation of the "perfect sense of hearing" health state) was 0.73 ($SD = 0.16$; median, 0.75). When using formula 1 (transformation in absence of multi-morbidity), the mean hearing-specific health state preference at baseline (0.51) corresponded with a mean health state preference of 0.66. When formula 2 (transformation with the presence of multi-morbidity) was used, 0.51 corresponded with a mean health state preference of 0.52. The hearing-specific health state preference at T1 (0.77) corresponded with health state preferences of 0.85 (in absence of multi-morbidity) and 0.64 (with multi-morbidity). At T2 the

Table 1. Results of the ADPI

ADPI		Baseline		T1			T2		
Description[a]	N	Mean	SD	Mean	SD	p Value[d]	Mean	SD	p Value[d]
Detection of sounds	78	1.99	0.44	2.92	0.27	.000	2.88	0.36	.000
Intelligibility in quiet	78	1.91	0.40	2.87	0.34	.000	2.94	0.25	.000
Intelligibility in noise	78	1.95	0.39	2.51	0.68	.000	2.35	0.63	.000
Auditory localization	78	2.15	0.55	2.62	0.55	.000	2.66	0.56	.000
Distinction of sounds	78	2.38	0.57	2.84	0.46	.000	2.87	0.34	.000
Health state preferences	N	Mean	SD	Mean	SD	Paired difference	Mean	SD	Paired difference
Hearing-related VAS	76[b]	0.51	0.13	0.77	0.11	0.26[e]	0.78	0.11	0.27[e]
Transformed VAS Formula 1	73[c]	0.66	0.13	0.85	0.09	0.19[e]	0.85	0.07	0.19[e]
Transformed VAS Formula 2	73[c]	0.52	0.10	0.64	0.06	0.12[e]	0.64	0.05	0.12[e]

[a]Minimum is 1 and maximum is 3.
[b]Two persons did not complete the condition-specific scale at T1.
[c]Five persons did not value the health state "deaf" for all three measurements.
[d]Wilcoxon signed ranks test.
[e]Paired difference statistically significant at the .000 level (paired samples t test).

scores were almost the same. The paired difference between baseline and T1 was 19% (in absence of multi-morbidity) and 12% (in presence of multi-morbidity). Both paired differences were statistically significant ($p = .000$). The paired differences from baseline to T2 were similar (Table 1).

The Marker States in the ADPI

Some participants found it difficult to attach values to the hypothetical marker states, which led to some missing values. A total of 68 respondents valued all marker states at T0, T1, and T2. At baseline the mean valuation of the marker state "deaf" was 0.29 points with a standard deviation of 0.20. The same question was asked at T1 and T2, and the valuations were 0.33 (SD, 0.22) and 0.29 (SD, 0.17), respectively. The difference in values was not statistically significant. The valuations of "mild asthma" at baseline and the two follow-ups were 0.62, 0.67, and 0.67, respectively. The valuation at baseline was lower than the valuation at follow-up, but this was not statistically significant. The difference in valuations of "severe heart failure" (0.19, 0.17, and 0.19, respectively) and "blind" (0.17, 0.17, and 0.14, respectively) were not statistically significant. The stability of the marker states was assessed using Pearson correlation coefficients and the average intraclass correlation coefficient (ICC). Both the Pearson correlation coefficients and the ICCs were low to moderate, which was indicative of a large variation in individual scores. The marker state "mild asthma" had lower Pearson correlation coefficients and ICCs than the other marker states. The marker state "mild asthma" had, as expected, the highest valuation, but the valuations were not as high as had been assumed (between 0.62 and 0.67 rather than between 0.80 and 0.90). The valuations of the marker state "severe heart failure" (between 0.17 and 0.19 rather than between 0.30 and 0.40) and "blind" (between 0.14 and 0.17 rather than between 0.40 and 0.50) were also lower than assumed (Table 2). All respondents attached the highest valuation at "mild asthma," and 35 respondents attached the lowest valuation at "severe heart failure." "Blind" was valued as the worst marker state by 27 respondents, and "deaf" by 6 respondents.

Table 2. Marker State Scores

	Deaf			Mild asthma			Severe heart Failure			Blind		
Marker states	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Baseline	77	0.29	0.20	77	0.62	0.18	77	0.19	0.20	77	0.17	0.21
T1	71	0.33	0.22	72	0.67	0.15	70	0.17	0.18	72	0.17	0.24
T2	72	0.29	0.17	73	0.67	0.12	72	0.19	0.20	73	0.14	0.21
	N	Correlation		N	Correlation		N	Correlation		N	Correlation	
Baseline T1[a]	72	.235[c]		71	.235[c]		70	.144		72	.103	
Baseline T2[a]	73	.237[d]		72	.120		72	.364[d]		73	.367[d]	
T1–T2[a]	70	.408[d]		68	.225		67	.498[d]		70	.561[d]	
Baseline T1, T2[b]	70	.570		68	.434		67	.594		70	.606	

[a]Pearson correlation coefficients.
[b]Average measure intraclass correlation.
[c]Pearson correlation statistically significant at 0.05 level, two-tailed.
[d]Pearson correlation statistically significant at 0.01 level, two-tailed.

Table 3. EuroQol Results

EQ-5D		Baseline		T1			T2		
Health state description	N[a]	Mean	SD	Mean	SD	p Value[b]	Mean	SD	p Value[b]
Mobility	77	2.63	0.49	2.68	0.47	.317	2.67	0.47	.491
Self-care	77	2.91	0.29	2.94	0.25	.705	2.90	0.31	.739
Daily activities	77	2.81	0.43	2.78	0.45	.439	2.78	0.47	.686
Pain and complaints	77	2.53	0.62	2.55	0.64	.858	2.58	0.59	.507
Feeling	77	2.77	0.46	2.91	0.33	.012	2.86	0.39	.071
Health transition	77	2.01	0.52	2.00	0.58	.970	2.05	0.56	.608
Health state valuation		Mean	SD	Mean	SD	Paired difference	Mean	SD	Paired difference
Visual analog scale	77	0.69	0.17	0.71	0.15	0.02[c]	0.71	0.15	0.02[c]

[a]One person did not fill in the feeling question at baseline, and one person did not complete the EQ-5D at T1.
[b]Wilcoxon signed ranks test.
[c]Paired difference not statistically significant.

EQ-5D Results

The scores on the first five questions of the EQ-5D regarding the dimensions of overall health showed little change over the three measurements. Only the feeling dimension improved significantly from baseline to T1. The results on the visual analog scale of the EQ-5D showed slight improvement after the hearing aid fitting (paired differences, 0.02); however, these improvements were not statistically significant (Table 3). The correlation between change in hearing-related health state and change on the EQ-5D visual analog was −0.039.

DISCUSSION

The aim of this study was to develop a preference-based questionnaire to determine health state preferences associated with hearing disabilities. The ADPI proved to be practical to use, even in an older hearing-impaired population, considering its shortness and the low number of missing values. In the intervention study, gain in health state preference after hearing aid fitting was assessed. All aspects of subjective hearing disability showed a significant improvement after hearing aid fitting. It seemed plausible that the largest improvement was found in the aspects "detection of sounds" and "intelligibility in quiet" and the smallest improvement in "intelligibility in noise," since hearing aids are more effective in situations with little background noise. The hearing-specific visual analog scale of the ADPI showed an improvement of 27% after hearing aid fitting. As expected, correlation of hearing-specific health state with hearing loss was low, while correlation with reported degree of hearing aid satisfaction was higher. This indicates that the construct validity of the ADPI was satisfactory. The equivalent of the gain on the hearing-specific scale on the generic scale was 0.12. Under the influence of multi-morbidity, the gain on the generic scale decreased with 0.07 (from 0.19 to 0.12). In general, scores on the ADPI showed that hearing aid fitting was effective in solving hearing-related problems and that the scale was sensitive to this change.

The reliability of the ADPI was investigated using the valuations of the hypothetical marker states. The mean valuations of the marker states were similar, and the ranking of the marker states was in concordance with expectation. The large individual variation of the valuations of the hypothetical marker states found in this study was consistent with other studies (2;24). The valuations of the marker states were all considerably lower than had been expected based on literature. This could indicate that the values respondents attached to their own hearing-related health state were also quite low. A possible explanation could be found in the fact that respondents had only recently admitted to themselves, and their family and friends, that they were hearing-impaired and in need of a hearing aid. As a result they might have increased their perception of the relative seriousness of health states related to hearing problems. However, this hypothesis could not be supported by the results of other studies.

The transformed health state outcomes of the ADPI were quite sensitive toward the valuations of the health states that marked the endpoints of the hearing-specific scale. Therefore, a careful choice of the population used for the valuation of the endpoints seemed important. A major advantage of the transformation is that the influence of multi-morbidity on change in generic health state is revealed and held constant during the period of intervention. The underlying assumption was that no interaction between the impact of hearing impairment and the impact of other health problems on overall health state preferences was present. This assumption is questionable, and further research is necessary to investigate the relationship between the specific health problem under investigation and other health problems that may be present. As expected, the EQ-5D did not show a statistically significant effect of hearing aid fitting on generic health state. Only the question regarding "feelings" showed improvement after hearing aid fitting (statistically significant at T1). The correlation between the score on the hearing-specific visual analog scale of the ADPI and the score on the EQ-5D visual analog scale was, as expected, low.

POLICY IMPLICATIONS

The merits of condition-specific preference-based instruments relative to descriptive ones have been recognized by other authors as well, and this has led to the development of preference-based instruments such as the McKnee for patients undergoing total knee replacement (2), and the Rhinitis Symptom Index and the Asthma Symptom Index (20;21). The outcomes of specific preference-based questionnaires can be used in cost-effectiveness analyses that provide information for resource allocation decisions within patient groups. The lack of sensitivity of the existing generic preference-based instruments could become a larger problem in the future, since it is likely that in the future cost-effectiveness analyses will be more frequently performed for medical interventions that lead to relatively small changes in quality of life and no change in the duration of life. Not being able to detect small effects of these interventions in older persons can lead to biases in cost-effectiveness ratios, and therefore in underestimating the cost-effectiveness of interventions for these substantial patient groups. Three features of the ADPI are innovative. First, since the aspects of subjective hearing disability are associated with technical aspects of hearing aid performance, the relative contribution of each of these aspects to the (change in) hearing-specific health state could indicate the relative importance of certain features of hearing aids for hearing aid users. This information is useful for clinical decision models about hearing aid fitting and research and development of hearing aid technologies. The allocation of the weights per aspect can be achieved by using the method of egalitarian evaluation (19). A paper concerning the outcomes of this allocation for the population described in the present study is in preparation. Second, the ADPI provides specific health state preferences as well as specific preferences framed in overall health. The advantage of this method is that change in health state is measured on a scale that is most suited for the purpose of the study but also interpretable on a generic scale. The method of framing specific health state preferences in overall health could be applied to other specific health problems as well. Further research needs to be done to determine whether "framed" health state preferences are suited for mutual comparison when different health problems are concerned, and hence different endpoints of the specific VAS are used. Third, the descriptive part of the ADPI also could be useful as a taxonomic health state description in population surveys to determine population preferences for hearing-related health states.

In summary, the ADPI is a feasible preference-based measure to obtain direct preferences for hearing-related health states, framed in overall health. These health state preferences are needed for clinical decision making and economic evaluation studies about rehabilitative options for audiological disabilities.

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